DOCUMENT RESUME

ED 128 182 SE 020 958

AUTHOR	Austin, Howard
TITLE	Teaching Teachers LOGO, The Lesley Experiments. Artificial Intelligence Memo Number 336.
INSTITUTION	Massachusetts Inst. of Tech., Cambridge. Artificial Intelligence Lab.
SPONS AGENCY	National Science Foundation, Washington, D.C.
REPORT NO	LOGO-23
PUB DATE	Apr 76
GRANT	NSF-EC-40708-X
NOTE	27p.
AVAILABLE FROM	The Artificial Intelligence Laboratory, 545 Technology Square, Cambridge, MA 02139 ($1.30)
EDRS PRICE	MF-$0.83 HC-$2.06 Plus Postage.
DESCRIPTORS	Artificial Intelligence; *Computer Oriented Programs; *Educational Environment; Elementary School Teachers; Higher Education; Learning Activities; Learning Theories; *Mathematics Education; *Research; *Teacher Education

ABSTRACT

This paper reports a study designed to determine how well teachers would learn the ideas embodied in the instructional sequences developed by the LOGO laboratory for use with elementary students. Approximately 30 pre-service and inservice elementary teachers were given 32 hours of instruction using the LOGO curriculum. Initially all students used the "Turtle" sequence; in latter portions of the course participants selected or designed their own projects; most investigated the juggling sequence. Results of the study indicated that the teachers learned the materials, and were able to apply their knowledge. They differed from children using the system in that they generally knew what they wanted but sometimes did not know the appropriate LOGO vocabulary. On the whole, they were less willing to try new ideas than children were. In general, they were enthusiastic about the system and anxious to have their students use it. (SD)

****
* Documents acquired by ERIC include many informal unpublished *
* materials not available from other sources. ERIC makes every effort *
* to obtain the best copy available. Nevertheless, items of marginal *
* reproducibility are often encountered and this affects the quality *
* of the microfiche and hardcopy reproductions ERIC makes available *
* via the ERIC Document Reproduction Service (EDRS). EDRS is not *
* responsible for the quality of the original document. Reproductions *
* supplied by EDRS are the best that can be made from the original. *
****

ED128182

U.S. DEPARTMENT OF HEALTH, EDUCATION & WELFARE
NATIONAL INSTITUTE OF EDUCATION

THIS DOCUMENT HAS BEEN REPRODUCED EXACTLY AS RECEIVED FROM THE PERSON OR ORGANIZATION ORIGINATING IT. POINTS OF VIEW OR OPINIONS STATED DO NOT NECESSARILY REPRESENT OFFICIAL NATIONAL INSTITUTE OF EDUCATION POSITION OR POLICY

MASSACHUSETTS INSTITUTE OF TECHNOLOGY

A.I. LABORATORY

LOGO MEMO 23

AIM 336

April 1976

TEACHING TEACHERS LOGO

The Lesley Experiments

by

Howard Austin

Abstract

This research is concerned with the question of whether or not teachers who lack specialized backgrounds can adapt to and become proficient in the technically complex, philosophically sophisticated LOGO learning environment. Excellent results were obtained and are illustrated through a series of examples of student work. The report then gives some brief observations about the thought styles observed and concludes with suggestions for further work.

The work reported in this paper was supported by the National Science Foundation under grant number EC40708X and conducted at the Artificial Intelligence Laboratory, Massachusetts Institute of Technology, Cambridge, Massachusetts.

The views and conclusions contained in this paper are those of the author and should not be interpreted as necessarily representing the official policies either expressed or implied of the National Science Foundation or the United States Government.

SE020958

TEACHING TEACHERS LOGO

I. INTRODUCTION

LOGO is an exciting new learning environment, developed at MIT, which draws heavily on the ideas of computer science, Artificial Intelligence in particular, and Piagetian Psychology.

> Initially LOGO research was primarily concerned with teaching mathematics at the elementary school level. As the research project matured, the emphasis was gradually broadened to include a much wider variety of subjects, such as music, physics, and biology, and in addition a much greater age range (see reference 2)

This research then is specifically concerned with the question of how well teachers who have had little or no training in either mathematics or computer science adapt to an environment in which the principal tool is the computer and the primary subject matter at least initially is mathematics.* Questions like this one which are concerned with the transferability of laboratory results to real world situations are especially important to LOGO due to its extensive use of relatively complex technology and the existence of widespread aversion to that technology. I believe however that the results contained herein and their implications for ed-

* Previous teacher programs have been conducted by S. Papert, C. Solomon, and I. Goldstein on a smaller scale in the summer of 1972. The experiments reported herin were conducted in 1973 - 1974.

ucation research and teacher education are relevant not only to LOGO but to the general community of educational technologists.

II. OVERVIEW OF THE RESEARCH PLAN AND THE REST OF THE PAPER

The questions involved in educating LOGO teachers factor into two major areas: 1) What are the problems involved in teaching adult teacher trainees the ideas embodied in the current LOGO curriculum (which was originially designed with children in mind), and 2) What kinds of problems arise when the trainees actually become teachers themselves and have their own LOGO students.

Since these areas involve fairly complicated issues, this paper deals primarily with question one. Question two will be examined in detail in a follow-up study using the results of the current research.

The rest of the paper is organized as follows:

Section III contains student background and class organization information

Section IV gives an extended series of examples of student work as well as discussions of their relevance to experimental goals.

Section V analyzes some of the problems observed during the course of the experiment and makes recommendations for the follow-up experiment.

III. STUDENT BACKGROUND AND COURSE ORGANIZATION

The subjects used in the experiment were volunteers selected from both the graduate and undergraduate ranks of Lesley College,* a local teachers college which specializes in elementary education. Approximately thirty subjects were involved, spread over three different "courses."

Of those who completed the program, nine were employed during the academic year as full time teachers in local school systems and additionally pursuing graduate work at Lesley; three were enrolled full time in graduate school, and the rest were full time undergraduates at Lesley.

Each course met for a total of 32 hours under a variety of fairly loose organizational formats. The initial subject in each course was the Turtle Geometry (i.e., mathematics) component of the LOGO curriculum.** Roughly one third of the overall time was spent there with the other two thirds being divided evenly between a survey of other components of the LOGO environment (e.g., MUSIC, JUGGLING, PHYSICS) and individual projects.

---

* In conjunction with Dr. Mark Spikell.

** For more information about Turtle Geometry or other parts of the LOGO curriculum see "The LOGO Primer" (Reference 1)

IV. THE STUDENT PROJECTS

A Digression About LOGO Philosophy

Although the word LOGO has been used both as the administrative name of a particular research group at MIT as well as the name of the programming language developed by that group, LOGO is most essentially an education philosophy. One of the ultimate aims of that philosophy is the development of both a physical environment and a set of ideas which when used properly will allow the creation of truly independent intellectual agents.

It is important to note the difference between this difficult goal and the usual sort of educational goals (in classrooms where conformity appears to be the watchword) when trying to understand what LOGO is all about. This is particularly important when trying to evaluate a LOGO student's progress in general of the specific examples which follow.

> Another important aspect of LOGO philosophy which is also worth noting for future reference at this point is the concept of a powerful idea. To quote Papert, "the first powerful idea is the idea of a powerful idea." When thinking about things in general and "intellectual" problems in particular, some ideas are for more important, occur far more frequently, have greater effect, i.e., are more powerful than others. The computer science notions of "debugging" and "naming" are further examples of powerful ideas. These ideas are cornerstones

of the LOGO educational philosophy. They are mentioned here as brief indications of the epistemological and computational aspects of the present experiment. The ideas are discussed at length in references 1-5.

Back to the Students

As mentioned before the first part of each course was devoted to the basics of getting the computer to do things and to some of the standard LOGO sequences. The latter portions of each class were used to allow each student to chose, design, and implement a project completely of his or her own choosing. These projects are excellent illustrations of the kinds of activities which might be envisioned as components of a LOGO teacher training curriculum as well as the intellectual development of each student.

The Turtle Guided Tour

Perhaps the most novel and centainly the most ambitious project initiated was a collective effort aimed at developing a LOGO system demonstration program. Like most busy installations LOGO has numerous visitors, requests for group tours, etc. The visitors are usually given a somewhat standardized movie and tour sequence by a LOGO staff member. The participants in this project (six of them altogether) planned to go one step better. The turtle would be programmed to give the tour.

The tasks were divided up by the students according to individual interests. They decided that the script should begin with a loud musi-

cal fanfare played on the LOGO music box.

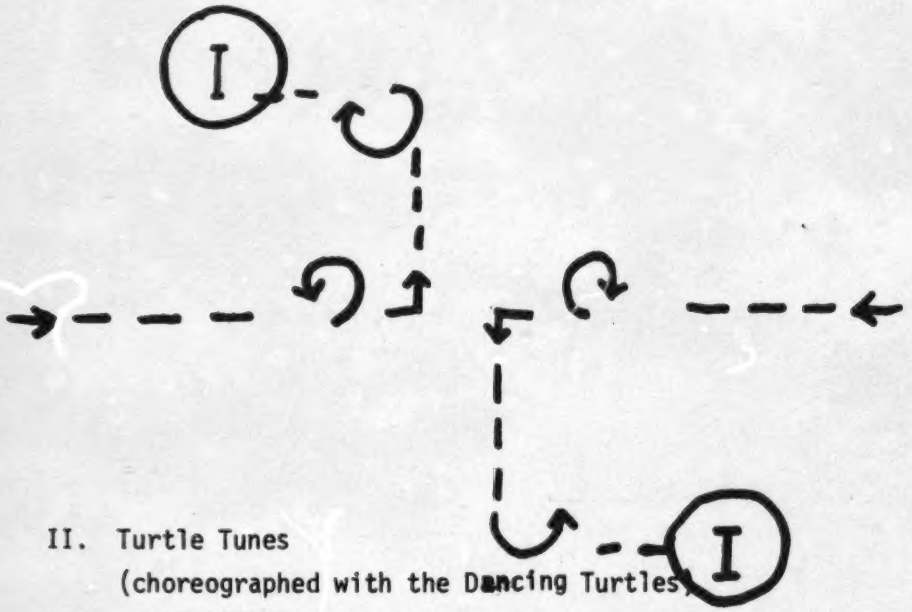
> The LOGO music box is a device which understands commands of the form "play this note ____, for this duration____." Examples of a fanfare program and a drum cadence program are given below. For details and further examples see "The LOGO Primer" (Reference 1).

```
TO FANFARE                                  TO CADENCE
10  PLAY [6 6 6 12 6 12] [2 2 2 4 2 8]      10 BOOM 2
20  PLAY                                    20 SSH  2
END                                         30 CADENCE
                                            END
```

After the fanfare the touchsensor turtle marches forward (under program control) in step with a music box drum cadence until it triggers a specially rigged movie projector.

When the movie, which itself is essentially an introductory lecture about LOGO, is over, another LOGO device, the voice synthesizer, under program control vocally directs attention to various other devices. The student designed programs which control these devices are activated at the correct time by internal counter loops so that the whole sequence of events is completely under program control. The following list gives an indication of the kinds of tour events the students planned for. The list is obviously richly open-ended.

I. Dancing Turtles



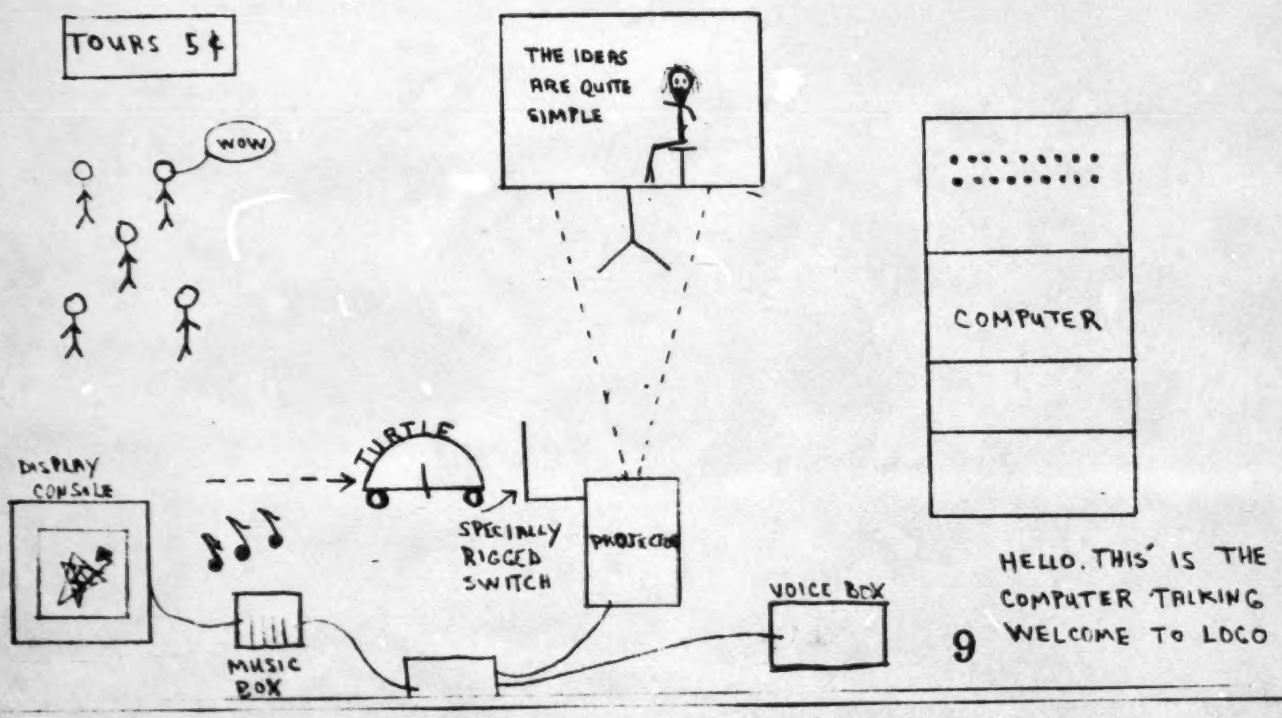
II. Turtle Tunes
(choreographed with the Dancing Turtles)

III. POLY/SPIRAL Light Show
(See Page 8)

IV. Conversational Program

V. Animated Cartoon Movies

THE TURTLE GUIDED TOUR



Animation Projects

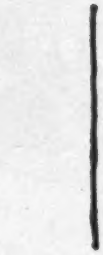
The single most popular area for student projects proved to be the construction of drawings and/or animated cartoons for the CRT display device. Projects in this area have the dual advantages of excellent motivation, since they are almost entirely student generated, as well as non-trivial complexity, since even fairly simple figures frequently require a good deal of planning analysis, program control structure, and debugging work.

Dale's Light Show

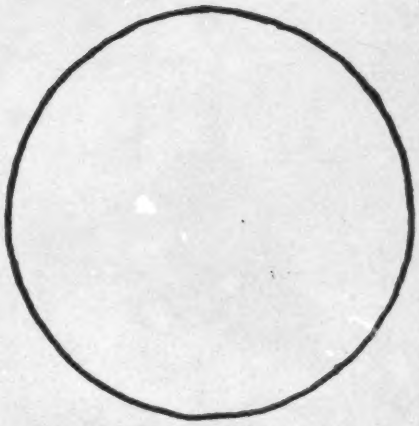
Several of the display projects exhibited a notable degree of both artistic and computational sophistication. The previously mentioned POLY/SPIRAL/INSPI Light Show is a good example.

> POLY is a very popular LOGO program which draws a remarkable variety of geometric figures. SPIRAL and INSPI are slight variations of POLY which produce suprisingly different behavior. The programs and some of the figures they draw are illustrated in figures 1 and 2.

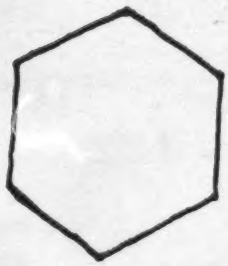
```
TO POLY :SIDE :ANGLE
10 FD :SIDE
20 RT :ANGLE
30 POLY :SIDE :ANGLE
END
```



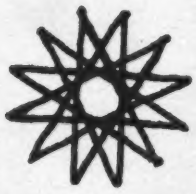
POLY 100 180



POLY S 13

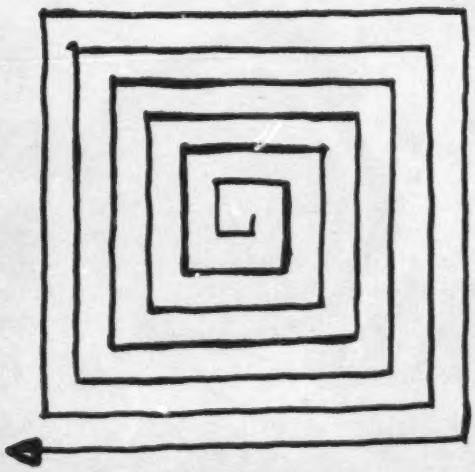


POLY 50 60

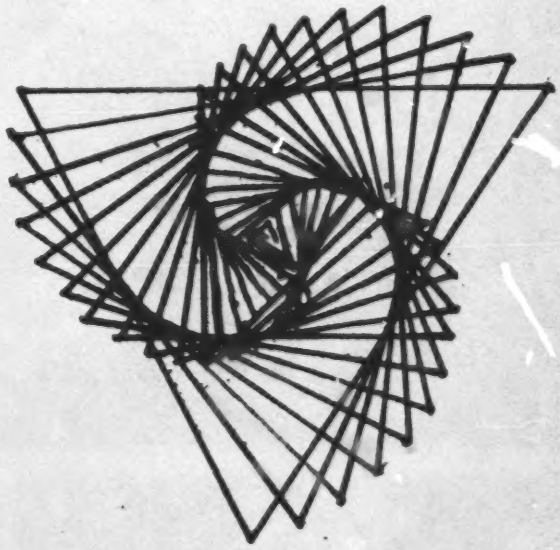


POLY 100 150

```
TO SPIRAL :SIDE :ANGLE :INC
10 FD :SIDE
20 RT :ANGLE
30 SPIRAL :SIDE+ :INC :ANGLE :INC
END
```



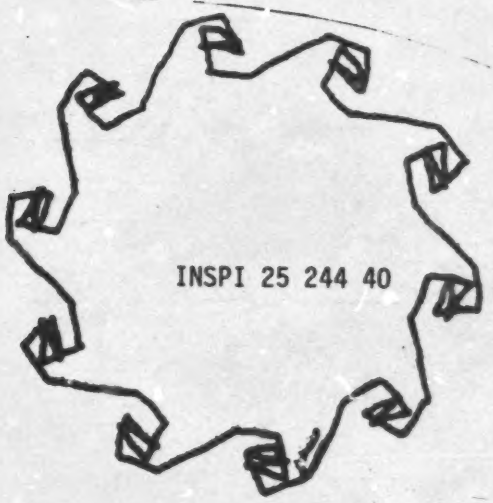
SPIRAL 10 5 10



SPIRAL 5 123 5

FIGURE 2 INSPI

```
TO INSPI :SIDE :ANGLE :INC
10 FD :SIDE
20 RT :ANGLE
30 INSPI :SIDE :ANGLE+ :INC
END
```



POLY and friends are interesting programs in their own right and Dale, the project designer, had a great deal of fun exploring their behavior in the Turtle Geometry portion of her class. She also liked display animations so when it came time to pick a project she decided to produce a "light show" consisting of figures drawn by POLY, SPIRAL and INSPI.

Normally these programs utilize the infinitely recursive control structure illustrated by line 30 of the POLY program. Each time line 30 is executed, POLY "calls itself" and hence starts all over again. So in its current form the program will never stop and hence cannot easily be used as a subcomponent of a larger process.

Dale had as her basic plan the idea of using a sequence of POLY figures, intermixed with a sequence of SPIRAL figures, along with other random "explosion-like" happenings. Hence her first task was to modify the control structure of each program so she could stop it after a specified number of repititions by means of a counter.

```
TO POLY :SIDE :ANGLE :N
10 IF :N = 0 STOP
20 FD :SIDE
30 RT :ANGLE
40 POLY :SIDE :ANGLE :N-1
END
```

Hence the command POLY 100 90 4 draws:

but POLY 100 90 3 draws:

Then she designed superprocedures in which she systematically varied the inputs to each program, activated each procedure at the proper time and cleared the display screen after each activation. One variation on this theme is illustrated below. Obviously many others are possible.

```
TO LIGHTSHOW  :SIDE  :ANGLE :INC  :IN
10 POLY :SIDE :ANGLE :N
20 WAIT 1
30 CLEARSCREEN
40 MAKE ANGLE  :ANGLE + 10
50 SPIRAL :SIDE+ :INC :ANGLE :INC :N
60 WAIT 1
70 WIPECLEAN
80 CONTROL :SIDE :ANGLE :INC :N
END
```

A final touch was to put the display screen into WRAP mode which allows lines which "run off" the usual display area boundaries to reappear on the "other side" (frequently in surprising ways).

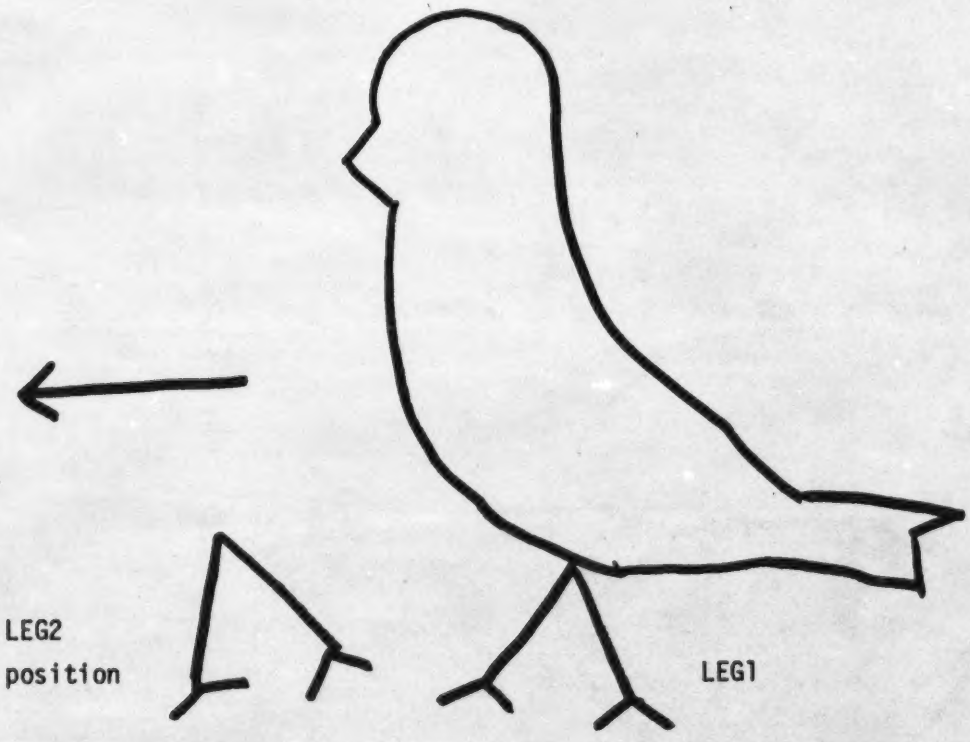
The results beggar the printed page. Geometric patterns come spiraling out towards you intermixed with strobe-like flashes of polygons squiggles and stars. It was a remarkably beautiful blend of mathematical and artistic inspiration, yet it was completely Dale's own creation.

More Display Projects

Figure 3 gives some further examples of display projects. The plot is simple in each case (in Strutter the bird simply walks across the screen, in FLOWER MOVIE a petal falls to the ground, in SEAWEED a multijointed line waves back and forth). Yet the programming jobs were non-trivial, especially for beginners and the results were pleasing due to the motion involved.

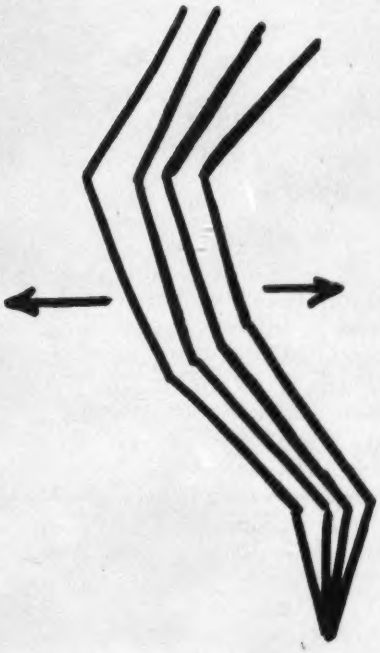
Figure 3 ANIMATED DISPLAY MOVIES

STRUTTER

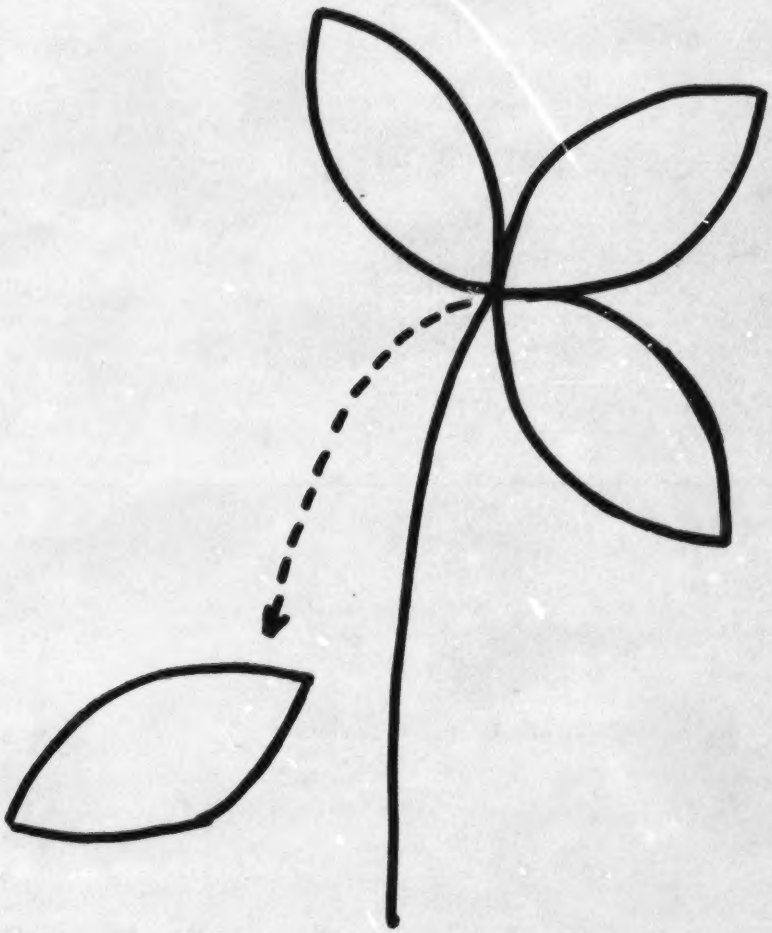


The Movie effect is achieved by alternately displaying "snapshots which contain different leg positions while at the same time moving the rest of the body forward.

DISPLAY MOVIES



SEAWEED



FLOWER MOVIE

DRAWING CURLS

The actual programs used to generate the STRUTTER movie along with a brief explanation of each routine are given below as an illustration of the amount of intellectual activity involved in creating simple animations. Remember, most of these people had never even seen a computer before the experiment, much less programmed one.

```
TO STRUTTER
5 CREATESNAPS1
6 CLEARSCREEN
7 CREATESNAPS2
8 CLEARSCREEN
10 DISPLAY :SPARROW 1
20 WAIT 30
30 WIPECLEAN
40 PENUP
50 FORWARD 20
60 PENDOWN
90 WIPECLEAN
91 PENUP
92 LEFT 90
93 FORWARD 90
94 RIGHT 90
95 PENDOWN
100 GO 10
END
```

STRUTTER is the top-level or master procedure for the movie. The subprocedures CREATESNAP1 and CREATESNAPS2 are used to bring into existence and name the two alternate bird posithe animation consists of. This section of the program causes one of the previously created snapshots (SPARROW1) to be displayed, asks the computer to wait for awhile so the picture can actually be seen and then erases the screen and moves into position for the next snapshot.
The same actions are repeated for snapshot 2 (SPARROW2)

```
TO CREATESNAPS1
10 BIRD
15 ORIENT1
20 LEGS
25 PENUP HOME PENDOWN
30 MAKE  SPARROW1 SNAP
END
```

CREATESNAP1 is used to control the original creation of the 1st animation frame, SPARROW1. It is made up of calls to BIRD, LEGS plus some interface code. Bird executes further calls to HEAD, BEAK, TUMMY, TAIL (some of which are not shown) to do the actual drawing.

```
TO HEAD
10 ARC 5 9 175
END
```

HEAD, for example is simply a call to the ARC subprocedure with the experimentally determined inputs 5, 9, and 175.

```
TO ARC : SIDE :ANGLE :LENGTH
10 MAKE COUNT 0
20 FORWARD :SIDE
30 RIGHT :ANGLE
40 MAKE COUNT  :LENGTH STOP
60.GO 20
END
```

ARC is the familiar POLY procedure modified to stop after a specified number of steps. It is the basic building block for TUMMY and HEAD.

Juggling

One of the essential attributes of a powerful idea is that it must be useful in a wide variety of contexts. In LOGO we have tried to emphasize this point by deliberately seeking out really different contexts in which to try out notions like debugging, subprocedurization, etc.

An example of such a context is the general area of physical skill acquisition. A subset of this area, which consists of "circus arts" like juggling, stiltwalking, and various other balancing tricks, is especially interesting because the skills appear to be so very complicated and mysterious when done well. These skills appear to be considerably removed from mathematical sorts of things, yet can easily be acquired via LOGO techniques.

Juggling, specifically cascade juggling, is one of our favorite examples of a mystifyingly complex physical skill which can be learned by virtually everyone in as little as twenty minutes.

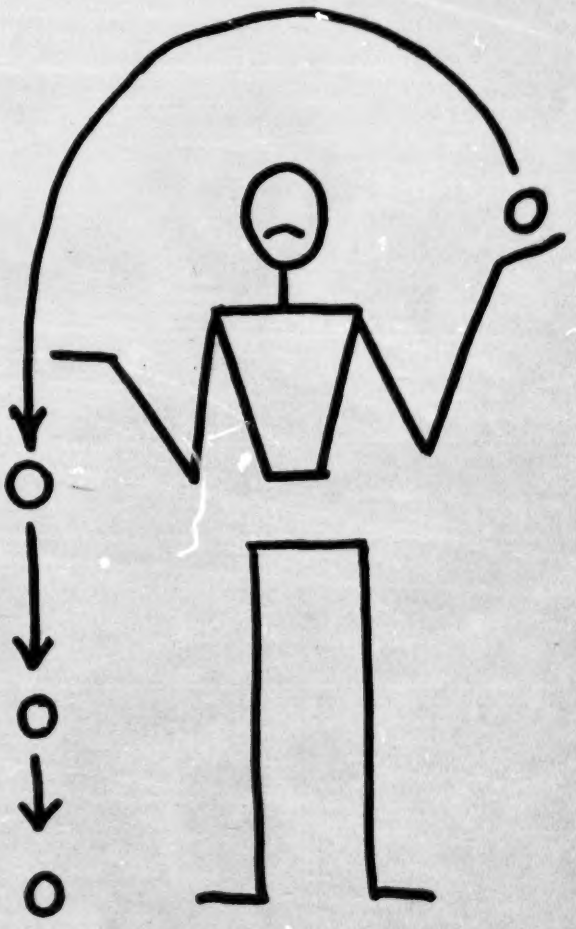
> Most people do not have very good theories about how difficult it might be to learn a new set of either physical or mental skills. Worse yet, if the first few attempts at learning the new skill meet with failure, then the usual response is to label it as too difficult, or impossible or something which required special prerequisites such as "math aptitude" or "coordination." Hence, for example both juggling and mathematics are usually considered to be beyond the reach of "ordinary" people.

Needless to say the teachers were highly skeptical of the proceeding assertion but were really intrigued by the possibility that they might actually be able to learn to juggle. Of course they all learned quite easily and in considerably less than twenty minutes at that. The interesting thing to note however was that they became a great deal more willing to believe in the notion of powerful ideas (which we had been talking about all along) as well as the LOGO thesis that both mental and physical activity is deeply computational in nature. Apparently the time scale was short enough and the activity complex enough to make the deeper theories seem really plausible for the first time.

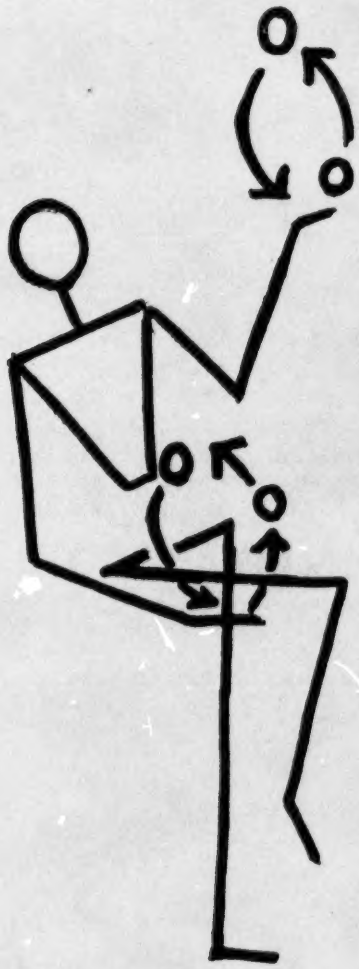
Virginia's Complaint

The most serious complaint about juggling was voiced by one of the older teachers (who like LOGO so much she started bringing her teenage daughter along). As soon as she had learned cascade juggling (with three balls), she had gone home and taught her son who was now angry at her because she didn't know how to do four balls at once. Unfortunately I did not know how to either at the time.

VIRGINIA'S COMPLAINT



HARVEY THE CLOWN



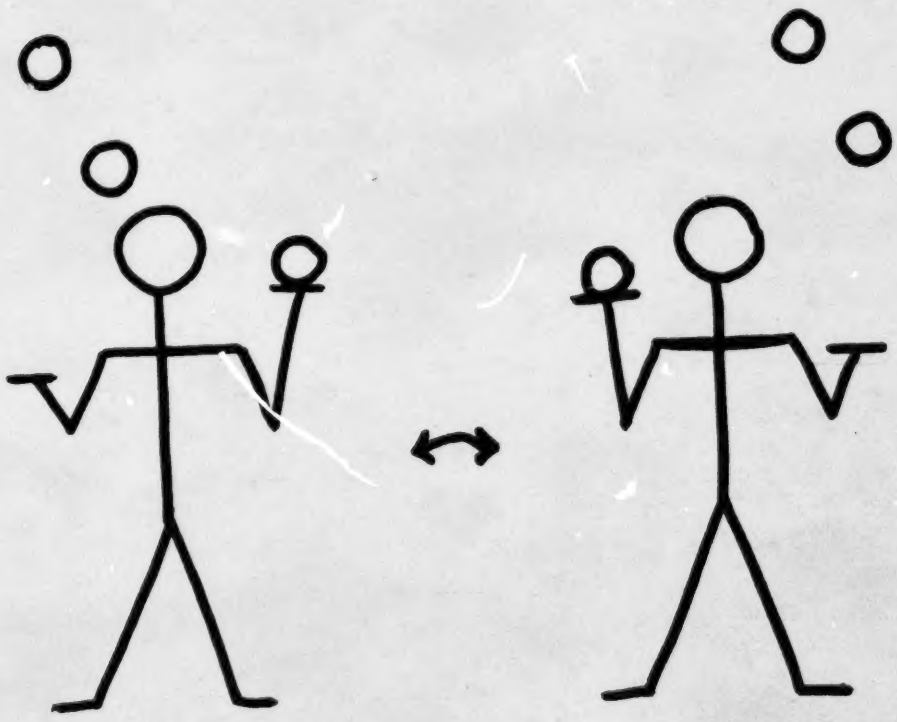
Harvey the Clown

Another desirable pedagogical characteristic of juggling is that it is an exceedingly rich area in the sense that learning the first step opens the doorway to many new and interesting problems. Harvey was our best example of this. As soon as he learned cascade juggling he, completely on his own, started working on various trick openings and stunts like tossing behind his back, under his leg, etc. Endless other variations are possible. For an excellent book on the subject see The Juggling Book, by Carlo.

Bea's Simulation

Juggling also provided the basis for noe of the more spontaneous creations in the experiment. Bea, who was very quiet, had been having trouble choosing a project. She really liked the juggling session though, so at her very next console session she was found programming the following juggling simulation (using incidently the very best of planning, debugging, . . . thought styles)

The only advice she had in the entire project was the suggestion that the simulation did not necessarily have to use the exact sequence of events real juggling requires.



IV. OBSERVATIONS AND ANALYSIS OF RESULTS

It should be abundantly clear by now that the basic answer to the first question posed by the experiment, "How well do the teachers absorb existing LOGO curriculum?) is "very well indeed." The teachers not only learned the specific materials presented, but were able to apply this knowledge in particularly creative ways to completely new problems.

It is interesting to speculate on why the same material works equally well for both children and adults. (It should be noted that there are some differences but qualitatively the results are the same). One possible explanation is that the LOGO environment has really begun to get at the roots of intellectual processes, and these processes are basically the same for both children and adults (Piaget notwithstanding).

Some comments about the previously mentioned differences are in order. In most cases the adults progress more rapidly than children usually do, and were also more likely to remember and profit from previous mistakes. However, they were equally likely to write long "linear" programs instead of breaking the problems into modularized subproblems and they had equal difficulty with the mechanics of the editing and filing systems. The observation that the adults were able to proceed more rapidly is probably due to the fact that they have many more experiences to relate new ideas to.

The adults frequently knew what they wanted to do but were missing the appropriate programming concept or LOGO primitive. Variablization was the most frequent illustration of this point. The adults frequently knew what variables were and furthermore that they needed one for the current problem, but didn't know how to express it in LOGO programming syntax. Children on the other hand often apparently need to be given a set of experiences so as to provide a framework for the interpretation of the task at hand.

The adults were less willing in general to try new ideas and approaches than children usually are. They were perhaps even inhibited by their previous educational experiences. They frequently raised objections to new suggestions or ideas of the form, "But won't the kids be frustrated by (say, the keyboard) or _____." In fact it has been our experience that kids don't have any such problems; only the adults. Kids just jump right in.

In terms of choosing projects, display animations proved to be the most popular area, music and touchsensor turtle projects were tied for second, and Turtle Geometry proved to be least popular despite (or perhaps because of) the amount of emphasis it received. This suggests that, as might be expected, adults tend to choose project areas which allow them to use previous experiences to fullest advantage.

> The most common complaint voiced by the teachers was that the course was not long enough to really get into things. Thirty two hours is not enough time even for a good introduction. The extra time is needed not so much for the programming experience per se, but rather to practice the philosophy extensively. It is the hardest part to appreciate fully yet it is the most important. For example, a random survey showed that the notion of powerful ideas had not really caught on yet. The ideas which did appear to go across somewhat were
>
> a) debugging
> b) naming
> c) subprocedurization.
>
> Although occasionally it became clear that these ideas were in somewhat presolid stages, it is interesting to note that the teachers were much better at <u>using</u> the ideas (as evidenced by their projects) than they were at <u>verbalizing</u> about them.

It appears to be a general property of technology that the more complicated the technology, the longer it takes to get up to critical mass and become functionally independent in that environment. For the present research this meant that as the number of students got large, it became increasingly difficult to answer questions, find bugs, etc., rapidly enough to keep the rest of the class from being hung up on trivial details. This problem has not been very important in the past due to the nearly one to one teacher/pupil ratios involved. It becomes increasingly

important as more realistic ratios (say 1 to 20) are approached.

V. CONCLUSIONS AND RECOMMENDATIONS FOR FUTURE WORK

One of the best things about learning something new is the fact that you can then teach someone else what you just learned. For most people that is a real ego trip. This feature of learning is particularly prominent in the LOGO environment. Graduate students, post docs., staff members and children alike all seem to have a great deal of fun designing subsystems, devices, etc. (which they just got through learning about themselves) for the use of "other" students.

> This seems to be almost a defining characteristic of good teachers. One teacher having just learned about juggling and physical skills such as stilt-walking and BONGO BOARD balancing, had her janitor build stilts for her 4th graders the very next day (and reported enthusiastic success).

Almost all of the teachers immediately petitioned to bring their own groups of kinds in for some LOGO classes. One specialist who worked with emotionally disturbed kids, planned to see how well some of her more serious cases did in the Turtle environment. All in all the enthusiasm present at the end of the 32 hour courses suggests that there should be little or no trouble arranging a follow-up experiment whenever time and

facilities allow.

The intended format for investigating question two, "How well do the trainees transmit their acquired knowledge ?", is initially oriented towards small pupil to teacher ratios. The plan is to take one or two graduates of the 32 hours course and give them at most two students of their own and observe them closely as they guide the students through a specific sequence of given topics. This arrangement is then repeated as often as necessary until enough data is obtained.

Let me conclude this article with the confession that I, like many others who have survived an educational institution, once believed that much of the chaos that is school today, stems directly from the "intellectual inadequacies" of the teachers employed therein. Happily this proved to be a thoroughly misguided notion. Teachers are not dumb! Rather they like so often has been the case even in scientific endeavors, have been laboring very diligently to find answers to the wrong questions (supplied, of course, by their leaders). Given the right preparation, i.e. the right set of questions, most teachers are capable of truly exciting, creative intellectual activity.

References

1) Austin, H., "The LOGO Primer," LOGO Working Paper 19, M.I.T. A.I. Laboratory (Jan. 1972).

2) Papert, S., "Uses of Technology to Technology to Enhance Education," LOGO Memo 8, M.I.T. A.I. Laboratory (June 1973).

3) Papert, S., "Twenty Things to Do with a Computer," LOGO Memo 3, M.I.T. A.I. Laboratory (June 1971).

4) Papert, S., "Teaching Children Thinking," Programmed Learning and Educational Technology, Vol. 9, No. 5, (Sept. 1972).

5) Papert, S., "Teaching Children to Be Mathematicians vs. Teaching Them About Mathematics," LOGO Memo 4, M.I.T. A.I. Laboratory (July 1971).

6) Carlo, The Juggling Book, Random House (1974).